Solving Industry Design Problems Using Engineering Technology and Industrial Design Student Teams

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Abstract - Engineering Technology programs are typically located in departments and colleges focused primarily on science and engineering. Industrial Design programs are typically located in art departments. At Western Washington University, the Industrial Design program is located in the Engineering Technology department. Having Industrial Design students and faculty members in the Engineering Technology department encourages collaborations that achieve learning objectives improbable in engineering-only collaborations. The students learn skills unique to their discipline, but also increase their understanding of the challenges of the other discipline, communication skills, and ability to compromise in order to achieve a shared objective. Additionally, the students work in an environment that better replicates professional teams where designers and engineers are using concurrent engineering.

Over the past three years, students from a Plastics Engineering Technology senior course (ETec 431) and an Industrial Design junior course (ETec 316) work together in small teams (2-3 students in each team) on industry-sponsored design projects. The course instructors utilized three very different approaches to these industry-sponsored design projects which resulted in different results.

Index Terms – Collaboration, Engineering Technology projects, Industrial Design projects, Industry-Sponsored Design Projects.

INTRODUCTION

When Engineering Technology programs are located in departments and colleges focused primarily on science and engineering, this approach encourages interaction and collaboration between the various disciplines of engineering and the natural sciences. When Industrial Design programs are located in art departments, this organizational approach allows the design students to develop creativity and design skills and interact with peers and faculty members during the development of those skills. A unique approach at Western Washington University offers opportunities for expanded learning objectives for students; the Industrial Design program is located in the Engineering Technology department. For the Engineering Technology students, these learning objectives include development of creativity tools, design for functionality and aesthetic, communication with non-technical peers, justification of material and manufacturing choices. For the Industrial Design students, these learning objectives include design for manufacturability, understanding of materials and properties, and justification of design aspects. All of the students increase their understanding of the challenges of the other discipline, communication skills, and ability to compromise in order to achieve a shared objective. Additionally, the students work in an environment that better replicates professional teams where designers and engineers are using concurrent engineering.

Over the past three years, students from a Plastics Engineering Technology senior course (ETec 431) and an Industrial Design junior course (ETec 316) work together in small teams (2-3 students in each team) on industry-sponsored design projects. These projects included: a passive dehumidifier intended for multiple applications, a solar-powered water purification system intended for developing countries, and portable ultrasound equipment by users such as Doctors without Borders.

INTELLECTUAL PROPERTY POLICIES

With industry sponsored projects, the intellectual property generated by students becomes an important issue to address. The university’s policy is that students own any intellectual property that they generate, however, industry is looking to benefit from new insights and ideas from these projects. The approach taken was to maintain that the goal of the collaboration was the educational and learning benefit for the students. The industry sponsor was not to consider a student project to be a replacement for professional consulting. So, they were instructed to provide a project or problem that was conceptual, futuristic, and not related to their current or near-future product line.

These projects adopted the Industrial Designers Society of America’s official “Guidelines for Industry-Sponsored Student Projects and Collaborations”[1]. The criteria summarized are as follows:

1. Projects with students must not be regarded as an alternative to professional consulting—they should serve as research, not development. Assignments primarily intended to produce immediate saleable results are not acceptable.
2. The sponsor brings professional expertise and knowledge to the classroom, adding a "real world" perspective to projects of mutual interest to student, faculty and sponsor. Sponsors are expected to provide direct informational support to the project and to evaluate progress through visits to the participating institution.

3. It is appropriate for the sponsor to contribute an unrestricted grant-in-aid to the school design department and to provide financial and/or other support to students for the construction of models and for project documentation.

4. Normally the sponsor will publicize the results of the project, with the students as the focus and the department and school included as participants. If there are potential problems regarding confidentiality and proprietary information, there should be a written agreement among all parties prior to the competition or collaboration.

5. The intellectual property rights of the resulting designs shall remain with the student or students, if a group effort was involved. In some cases, there may also have been substantial intellectual input from faculty. Should the sponsor wish to acquire the rights to produce or otherwise utilize a design beyond the immediate scope of the project or competition, those involved in the direct results of the work shall be compensated at a level comparable to a normal professional fee. This policy or any alternate agreement should be established in advance, in writing, with the student, school and sponsor.

These criteria are presented to each corporation before the project begins so that expectations are clear. It has worked well with these cases; however, sometimes an inspirational student project can develop great interest within the corporation. Then the project suddenly becomes a priority to commercially develop. If so, the industrial sponsor has the option to acquire the rights directly from the student or hire the students or faculty as professional consultants to further develop the product. Although these criteria are clear, there still exist grey areas that are difficult to predict and enforce.

PASSIVE DEHUMIDIFIER PROJECT

In 2007, a local company, Homax Products, wanted a low-cost but functional passive dehumidifier. This device uses a granular compound to absorb moisture from the air. When the compound is saturated, it can be dried or the device can be thrown away. These are commonly used in enclosed spaces that are prone to high humidity, such as closets, boats, storage sheds, under the sink, etc. Homax did not currently manufacture one of these devices, but felt it would fit into their existing product line.

I. Methodology – Passive Dehumidifier

Since Homax did not currently manufacture this product, the first task for the students was to research the existing market and determine how various companies had designed their products, what was good about each design and what could be improved from each design.

The design objectives and challenges that the students were presented included functionality, aesthetics, market, and design for manufacturability. Some of the items included:

- Perform better than the current design
- Aesthetically pleasing,
- Has a container that allows re-filling of the pellets
- Has a container that does not leak the water eliminated from the atmosphere, yet that makes it easy to dispose of its contents
- Design carries over to many different container sizes: 2-4 pints, 1-2 gallons, etc.

Each student from both classes developed multiple concepts on their own and then presented these to the entire class. The students were then organized into two-person teams (a Plastics Engineering Technology senior and an Industrial Design junior). Based on feedback from classmates and the instructors, each student team chose one concept to refine. The ID students refined their team's design for functionality and then presented it once more to the entire class for input. Each team used this input to create the final two deliverables, a prototype and detailed CAD drawings. The ID student’s task was to make a prototype of the final design using thermoforming. The PET student proceeded to address manufacturability issues and make CAD drawings of the team’s design. Once these were complete, each team gave a formal presentation of their final design and their prototype to their classmates, the instructors, and representatives from Homax.

The students and instructors completed the project with a discussion about the advantages and disadvantages to this way of approaching a design problem.

II. Results – Passive Dehumidifier

The final design was used by each student in each team to create two different deliverables for the final presentation. Because the ID students were manufacturing prototypes of their team’s concept using thermoforming, the designs tended to get modified slightly to aid in the manufacturing process. Because the PET students were creating CAD drawings of their team’s concept and addressing manufacturability issues (these devices would likely be injection molded), the designs tended to get modified slightly to aid in the creation of the CAD drawings or to make the device more easily manufactured by injection molding. By the time the team reconvened to present their deliverables to the sponsor, some teams had two very different versions of their concept to present. Figure 1 is an example of a team that continued to work together to ensure their design was consistent. Figure 2 is an example where the initial design, the final CAD drawings, and the prototype look very different from each other.

This approach to a design problem had too much “passing things over the wall” between designers and
engineers. The class discussed the concept of concurrent engineering and how the experience and designs may have been improved if more concurrent engineering practices had been employed. It was a great opportunity for the students to see the importance of concurrent engineering and also how the manufacturing process may change the design.

Cascade Designs requested that the students redesign the MSR/MIOX to be used for developing countries that do not have access to clean water. The job of collecting water is usually done by the children, so the design had to be very safe to ensure the concentrated bleach solution was not spilled on their skin. Also, the designs must incorporate a solar panel due to limited electricity supply in these remote regions.

I. Methodology – Solar Powered Water Disinfection

The design objectives and challenges that the students were presented included items such as:

• Must have clean, compact, durable, ergonomic look. Must be freeze, altitude, water and drop resistant.
• Low cost
• Should be sculpturally stylish with a futuristic look to help promote this as being new technology.
• Is rechargeable by sunlight.
• Completely self contained, only add salt & sunlight. Must protect user from oxidant.
• Easy to use - One button, one dose. Must be able to describe method in 4 pictures or less
• Primary function is water purifier. Secondary function can utilize indicator LED lights as lighting if desired.

Based on the results from the previous year, the instructors decided to investigate a new approach. The students were organized into two-person teams (a Plastics Engineering Technology senior and an Industrial Design junior). Each student was to develop their own unique design. Once the students had completed an initial concept, they met with their teammate for input. The Plastics Engineering Technology student acted as a consultant to the Industrial Design student regarding issues of manufacturability and durability. The Industrial Design student acted as a consultant to the Plastics Engineering Technology student regarding issues of functionality and how well the design addresses the design objectives. The students were given “feedback forms” that the instructors created. These forms listed aspects of the design that should
be reviewed and commented on by the consultant. This allowed the peer review to be targeted and thorough. During previous design projects, having students review each other’s work without direction resulted in great feedback for some students and little to no input for other students from their peers.

After the designs were refined based on the feedback the students received from their “consultant”, the designs were reviewed by the instructors and representatives from Cascade Designs. Another refinement of the designs was completed based on the feedback and then each student gave a formal final presentation of their design to their classmates, the instructors, and three representatives from Cascade Designs.

II. Results – Solar Powered Water Disinfection

Unique results compared to other design projects were achieved from this project. Since each student completed their own design, but received input from someone from another discipline with very different skills, the designs were substantially improved compared to each student’s early concept.

One challenge to this approach (each student doing their own design) was the substantial difference between the designs created by ID students and the designs created by PET students. The ID students’ designs were much more refined in their functionality and usefulness by the intended user (children), but still had manufacturing challenges. The PET students’ designs were simple to manufacture, but were very “boxy”, had little style, and may be difficult for a child to use safely. Some examples of these designs are in Figure 4 and Figure 5.

Cascade Designs presented the project at “Disinfection, 2009”, a conference held in April, 2009 sponsored by the Water Environment Federation. In the paper published in the proceedings, the list of questions that Cascade Designs posed to the students during the final presentations is included. These questions included:

- Does the form visually indicate how it is to be used, held and operated?
- How stable is the design to prevent tipping?
- Where are the fragile components (circuit board, solar panel, lights) located and are they adequately protected from breakage?
- How many housing parts are there and can they be reduced in number?

The authors of that paper from Cascade Design stated that the final presentation allowed the students to give justification to many of these questions while the Cascade Designs engineers provided feedback. Also, while no single student’s design concept was perfect, each concept had strong arguments supporting the ideation.

PORTABLE ULTRASOUND PROJECT

In 2009, the faculty members of the two courses were approached by SonoSite, Inc., a manufacturer of portable ultrasound equipment located in Bothell, WA. The challenge presented to the students was to design a portable ultrasound system for Sound Caring. Sound Caring, a non-profit division of SonoSite, is dedicated to bringing high quality ultrasound to patients who would otherwise not have access to this technology due to social conditions, remote location or poverty [3]. The Sound Caring program makes hand-carried ultrasound systems available to non-profit healthcare providers operating in austere environments throughout the world. Sound Caring currently supports programs in Asia, South America, the Caribbean and Africa.

I. Methodology – Portable Ultrasound

The design objectives and challenges that the students were presented include items such as:

- Access to power
- Transport of ultrasound systems and supplies (20+ lbs)
- Protection from mishandling in extreme environments
- Setting portable systems up for continuous use
- Getting systems through airport security and customs
- Sealed and easily disinfected
Based on the results from the previous two approaches, the instructors wanted to investigate a different way to organize the project. The students were given much more creative freedom and were required to develop one concept together. The teams continually met together with the instructors and representatives from SonoSite. The students were organized into two-person teams (a Plastics Engineering Technology senior and an Industrial Design junior). There were 14 teams in this project. The students researched the company, compiled a list of questions, and then traveled to SonoSite’s facility. At SonoSite’s facility, the faculty members and students received a tour of the design area and the assembly area to get a better understanding of the product. In order to better understand how the device functions, the portable ultrasound technology was demonstrated on multiple volunteer students’ carotid arteries, hearts, and aortic arteries. The students commented that they were impressed with the types of questions that students from the other discipline were asking and that they were already gaining an appreciation for the knowledge of their teammates.

To allow more creative input to the project from the students, each team was directed to choose a location and a condition for their design. Once a decision was made, each team completed research on the location’s economics, terrain, current health care situation, infrastructure, etc. Some examples include:

- Himalayas – mountain rescue (Figure 6)
- Darfur, Sudan – triage tent during war (Figure 7)
- Sierra Leone – pregnancy and pediatrics (Figure 8)
- Northern Canada – remote clinics
- Indonesia – natural disaster response

Teams worked together for seven weeks on their research and design. Every two weeks, designers and engineers from SonoSite and the two faculty members (one an engineer and one an industrial designer) would provide feedback as each team presented their design.

At the end of the seven weeks, each team made a final formal presentation of their design to the entire class, the instructors, and three representatives from SonoSite. The final designs included information about how the device addressed the challenges of the location and condition they chose. Additionally, each group had to explain how the device would be manufactured and how the assembly would address issues of durability and ease of disinfection.

II. Results – Portable Ultrasound

Unique results compared to other design projects were achieved from this project. In previous projects where students were given a design problem, by the time the project was complete many of the designs had a similar approach to addressing the functional objectives of the device. The students struggled with how to make their design distinctive from the rest and still meet the design objectives. With the Portable Ultrasound project, having each team create a unique health care situation in a remote location resulted in substantial diversity in the final designs.
This really allowed each team to have a design unique from their classmates, but have to explain how the design addressed the challenges of the user in the situation they imagined. This approach also allowed for students in the class to learn from other teams who took a completely different approach to the project.

Another unique learning objective achieved with this project was achieved within the ID-ET teams. The students stated repeatedly how much they learned from their teammate during the project. Engineering Technology students were given experience using the techniques ID students use to develop ideas, such as mind mapping and design for each function. Industrial Design students were given experience in design for manufacturability. Each team had to justify material choices, manufacturing processes, and assembly techniques. One challenge to this approach was that it was not clear which student in each team was responsible for the final deliverables of the project. The PET student was responsible for the CAD drawings included exploded assemblies. The ID student was responsible for putting the CAD designs into a rendered “context” that would help to explain the design.

**CONCLUSION**

Based on the results of the three different approaches to team-based design projects that are industry sponsored, there are some key recommendations:

- Clear objectives in writing from the sponsor are needed before the project begins. Many times at the start of an industry-sponsored project, the sponsor is still contemplating the project’s objectives and then modifies their objectives as they review student’s work. This may result in frustration for the sponsor, the instructor and the students.

- Clear division of duties between team members in necessary to ensure that each person of the team knows what deliverables he/she is responsible for. This is difficult if the students are not provided ample in-class time. Expecting students to meet outside of class proves to reduce quality and consistency.

- Using “feedback forms” to help guide the students when they are reviewing each other’s work helps them to be thorough and focused.

- Allow for plenty of time for concept review by peers, faculty members, and industry sponsors to ensure the highest learning achieved.

- Encourage students to prototype their designs when possible. Design for manufacturability is better solidified when prototyping is part of the design output.

**REFERENCES**


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